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Determinants of adoption of soil conservation measures in the hilly state of Meghalaya

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ABSTRACT

In India, a key barrier to agricultural production and food security is the depletion of soil and water resources. To address these issues, the government has adopted a number of soil and water conservation (SWC) initiatives in watershed form throughout the last few decades. The objective of this study was to examine the factors affecting the adoption of soil conservation measures in the study area. This study was carried out using a combination of research approaches. Information from 240 households was collected using a pre-tested schedule. The collected data was analysed using a binary logistic regression. Age, sex, education, off-farm income, livestock, credit, farm revenue, and training were all found to be strongly associated with the adoption of soil conservation practises in the state. The data also showed that farm size, tenure, farming experiences, and extension services all had a favourable impact on soil conservation adoption. This information enables prioritise the elements that influence adoption decisions as well as provide insight into the best approaches to improve soil conservation measures adoption in the state.

1. Introduction

Soil degradation is a serious environmental and agricultural issue that humans are confronted with (Blanco and Lal, 2008). Soil erosion has lost about a third of the world's arable land in the last 40 years, and it continues to do so at a rate of much more than 10 million hectares each year (Penning de Vries *et al.,* 2008; Pimental, 2006; Assefa, 2007). Soil degradation affects 147 million hectares (Mha) of land in India, with 94 Mha due to water erosion, 16 Mha due to acidity, 14 Mha due to flooding, 9 Mha due to wind erosion, 6 Mha due to salt, and 7 Mha due to a combination of variables (Bhattacharyya *et al.,*.2015). This is causing concern because India is home to more than 17 per cent of the world's human population and 15 per cent of the world's livestock population, but having only 2.4 per cent of the world's land area (Statistic Times, 2021).

In India, a key barrier to agricultural production and food security is the depletion of soil and water resources. Jammu & Kashmir and Nagaland have the highest percentage of land degradation (94%) among the Indian states. Large regions under mountains, cold deserts, and other damaged lands are mostly contributed to these issues. Uttar Pradesh, Madhya Pradesh, and Karnataka, all agriculturally dominant states, have 63, 50, and 46 per cent of their total area under degradation, respectively (Kumar *et al.,* 2011).

In the North East region, over exploitation of forest for fuel, timber, and fodder, shifting cultivation, poor land use practices, infrastructure development, land tenure systems of many ethnic tribes, and mining operations have all contributed to the degradation of NER's land resources. Arunachal Pradesh (2155 thousand ha), Manipur (1768 thousand ha), Meghalaya (1732 thousand ha), Nagaland (1550 thousand ha), Mizoram (1163 thousand ha), Tripura (785 thousand ha), and Sikkim have the most degraded land among the North East states, occupying of about 58 per cent of the overall geographical area (60 thousand ha) (ICAR-NBSS and LUP, 2005).

Furthermore, in Meghalaya, due to the unprecedented rainfall and its high intensity, the problems of soil erosion persist in the state. Furthermore, soil deterioration and major erosions was exacerbated by primitive and harmful agricultural practices such as *jhum* and

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bun (Shangpliang, 2018).

Land degradation, posed a serious danger to the country's natural resources. As a result, controlling land degradation is critical for long-term agricultural production.

To address these issues, the Government of India has adopted a number of soil and water conservation (SWC) initiatives in watershed mode throughout the last few decades (kumar *et al.,* 2021).

In Meghalaya, the Soil and Water Conservation Department, through their various government schemes and programmes seek to address land degradation issues through conservation, restoration and improvement of natural resources. The major programmes employed were, Watershed Development Project in Shifting Cultivation Areas (WDPSCA), Accelerated Irrigation Benefits Programme (AIBP), NABARD Loan- Soil & Water Conservation Scheme under RIDF, Soil and Water Conservation in the Catchment of River Kopili, Rashtriya Krishi Vigyan Yojana (RKVY) and The Cherrapunjee Ecological Project-Restoration of Degraded Lands under Sohra Plateau (GoM, 2021a). From the survey conducted, the prominent soil conservation measures adopted by the farmers in the state were bench terracing, contour bunding, peripheral bunding, loose boulder bunding and check dam. However, understanding the factors that influence a farmer's decision to adopt a certain conservation measure among the many options available is critical for providing insights and identifying target variables that promote adoption. Soil conservation programmes that are based on farmers' perceptions of soil erosion can be more cost effective (Shankar *et al.,* 2007). The purpose of this paper was to identify the major factors influencing farmers' adoption decisions, estimate the adoption elasticity of factors that are significant in explaining farmers' decisions in the study area, and draw conclusions that could aid in the development of policy and institutional interventions to encourage adoption.

2. Material and methods

Study area

The study was conducted in East Khasi Hills (about 25°07" and 25°41" N Latitude and 91°21" and 92°09" E Longitude) and Ri-Bhoi (about $25^0$15' and $26^0$15' and between East Longitudes $91^0$45' and $92^0$15') districts of Meghalaya (GoM, 2021a; GoM, 2021b). The districts are economically dependent on agriculture and the major crops that are mainly grown are Cabbage, Cauliflower, Chillies, Beans, Peas, Beat root, Carrot, Radish, Potato, Garlic, Lettuce, paddy, ginger, maize, pineapple and turmeric, *etc., (*Rajavardhan *et al.,* 2020; Das, *et al.*, 2020). Various programmes have been initiated and reported to have been successfully continuing across the state. It was reported that 37891.50 ha of land has been adopted in the different programmes with a total cost of ₹5228.90 lakh. Across districts, East Khasi Hills (5035.00 ha) has the highest area treated for soil and water conservation followed by Ri-Bhoi district (5000.00 ha) (GoM, 2021c). On basis of the total area treated for conservation measures, these two districts had been taken up for the present study.

Data and sampling procedure

To select the districts, blocks, villages and households, a multistage sampling procedure was used. This procedure allows selecting small sample units from larger ones while providing equal chances for all the participants to be selected. The survey covered 240 households from 12 villages, of which 120 households were adopters of soil conservation and 120 households are the non-adopters. From each districts two blocks each were selected based on the pilot survey. The household head (assumed to be the main decision maker in the adoption of soil conservation measures) was interviewed for the purpose of this study using a constructed and semi-structured questionnaire that covered a wide range of socioeconomic aspects of the household and village level, farming, institutions, the process of soil conservation adoption, and so on.

Analytical Tool

The link between the dichotomous dependent variable and the independent variables was investigated using a binary logistic regression model (Hyeoun-Ae, 2013). It allows the impact of several independent variables on the dependent variable to be determined. The goal was to find the determinant variables (Kalineza, Mdoe, and Moliz, 1999). Before employing the binary logistic regression results, the assumptions of binary logistic regression were tested. The binary logistic regression described below was employed.

$$\ln\left(\frac{P}{1-P_i}\right) = \beta_0 + \beta_i Z_i + \varepsilon_i$$

Where,

Pi = the probability that the i^{th} farmer will adopt soil conservation practices

1- P_i= the probability of ith farmers will not adopt soil conservation practices

β_0= intercept

β_i= Logit coefficient (i=1,2,3,……, n)

Z_i= Sets of explanatory variables for determining the adoption of soil conservations practices

ε_i= random disturbance term (i=1,2,3,……, n)

Variable selection

Dependent variable

Adoption is commonly specified in terms of a binary variable (Adopter./non-adopter) for farmers' adoption analysis. A dummy variable 1 was assigned for farmers who practise soil conservation and 0 for those who don't.

Explanatory variables

Adoption of soil conservation measures, like other agricultural technology adoption research (Adesina and Chianu, 2002; Sheikh et al., 2003; Herath and Takeya, 2003), is a complex process driven by a number of connected biophysical, socioeconomic, and institutional aspects. A wide range of household, farming, institutional, and agro-ecological factors are among the 13 potential explanatory variables that are anticipated to influence farmers' adoption of soil conservation in the research area (Table 1).

3. Results and discussion

Model validation

For binary logistic regression, the Hosmer and Lemeshow statistic was a commonly used test for testing model fit (Sidibe, 2005). The model's output is provided in Table 2. The overall percentage of correct predictions is 92.5 per cent. The p-value 0.506 uses the Hosmer and Lemeshow Goodness-of-Fit Test, which is computed from the Chi-square distribution with 11d.f. We fail to reject the null hypothesis that there is no difference between the observed and predicted values of the dependent, implying that the model's estimates very well fit the data at an acceptable level.

Results of the model and discussion

The major factors that influence the adoption of soil conservation technologies in the study area were identified by analysing the dependent variable i.e., the adoption of soil conservation against the 13 regressors.

The findings of the binary logistic regression analysis demonstrate that at the 5 per cent level, the farmers' age (estimates= -0.068**) played a significant influence in the adoption of soil conservation practises. Age has a negative effect on adoption, indicating that younger farmers are more likely to use erosion control techniques. Farmers get exhausted and unable to properly care for their fields as they age, according to the study. Younger farmers, on the other side, are more interested in new farming techniques. Younger farmers are more inclined to invest in soil conservation measures because they are more educated and aware of soil erosion concerns and solutions, according to Tiwari *et al.* (2008), Budry *et al.* (2006), and Mulugeta *et al.* (2001).

The size of the family is associated insignificantly but positively with the adoption of soil conservation techniques (estimates=0.173). Habtamu (2006), Million and Kassa (2004) and Eleni (2008) all reported similar findings. Small-scale household households, they claimed, are less inclined to accept soil conservation techniques because they lack the requisite labour to execute and maintain them. Farmers with larger family sizes, on the other hand, are less likely to continue using introduced soil and water conservation techniques, according to Fikru (2009); Foltz and Jeremy (2003); Aklilu (2006), because there is a labour shortage between off-farm activities that generate food and investments in soil and water conservation methods.

Farmers' gender played a significant influence in conservation measures being adopted. The findings revealed that the farmers' sex (estimates= 2.670**) had a positive and significant influence on adoption (p-value= 0.032). It was discovered that male farmers were more inclined to

Table 1. Description of variables included in Binary Logistic regression model

Variables	Description	Expected outcome
Age	Respondent's age (in years)	±
Family size	Number of household member	±
Sex	1 if household head is male, otherwise 0	±
Education	Number of schooling years	+
Off-farm income	Sources of off-farm income (1 if yes, otherwise 0)	±
Livestock	Number of Livestock	+
Landholding	Size of landholding (in hectare)	+
Incentives	Access to Incentives (1 if yes, 0 otherwise)	+
Farm income	Total farm income	+
Farming experience	Number of years involved in farming	+
Tenure	Land tenure (1 if owned, otherwise 0)	+
Extension	Visit of extension person (1 if yes, otherwise 0)	±
Training	Training receive (1 if yes, otherwise 0)	+

implement soil conservation practices. According to a study conducted by Aberha (2008) and Eleni (2008), male-headed families have a higher likelihood of participating in soil conservation techniques because these measures are labour intensive.

The adoption of soil conservation was substantially related with farmer education at a 1% significant level, as expected. This implies that farmers with a higher level of education will be more likely to employ soil conservation measures because they will have a better understanding of the benefits of doing so. Fikru *et al.* (2009) and Krishna *et al.* (2008), both reported on the favourable substantial impact of education.

Farm income, off-farm income, and livestock all have a strong and significant relationship with the adoption of soil conservation measures (at 5 per cent significant level). It has a detrimental impact on adoption in the case of landholding. The negative sign is that as a farmer's landholding expands his or her willingness to use erosion control techniques declines. These findings were consistent with earlier research (Habtamu, 2006; Garcia, 2001) This study, on the other hand, contradicts Tedesse and Belay (2004), who found that farmers with larger farms have more financial resources and land to devote to improving technology adoption.

When it comes to land features, tenure influenced the adoption of soil conservation measures (SCM) in a beneficial way. That was because tenure assured that the same area would be utilised in the future, providing incentives to participate in conservation activities and reap the long-term benefits (Gebremedhin and Swinton, 2003). Several studies have demonstrated that having a secure tenure has a favourable impact on soil conservation practises adoption (Shiferaw and Holden, 2000; Baidu-Forson, 1999; Teshome et al., 2013). As expected, the slope of the plot was substantially linked to a higher likelihood of SCM implementation (p-value0.05). This means that the cultivator is more likely to employ SCM if the slope of the plot is steeper.

The availability of institutional variables such as extension services, training, and incentives had a favourable effect on SCM adoption. Training (p-value 0.05) and credit (p-value 0.001) have a positive and significant relationship with the decision to adopt conservation practices, according to the findings. This means that having access to credit or financial aid, as well as instruction on conservation techniques increases the likelihood of them being adopted. Even though it was minor, extension service had a favourable impact on the adoption of soil conservation, as expected. Farmers that receive good information from extension professionals are more likely to use new soil conservation practises and keep existing ones, according to this study. The effect is minor, however, due to the low amount of engagement between farmers and extension employees. Similar findings have been reported by a number of other researchers (Mango *et al.,* 2017; Bekele and Drake, 2003; Mbaga-Semgalawe and Folmer, 2000). According to their findings, having access to a good extension service, training, and credit can help farmers not only recognise the negative effects of land degradation, but also become more aware of the available technology and financial assistance.

Table 2. Binary logistic regression model results for factors influencing adoption of soil conservation practices

Determinant	Estimate	Std. Error	P-value
Age	-0.068**	0.032	0.044
Family size	0.173	0.954	0.272
Sex	2.670**	1.231	0.032
Education	1.032***	0.310	0.001
Off-farm income	1.562**	0.104	0.032
Livestock	2.011**	0.022	0.021
Landholding	-0.324^{NS}	0.294	0.845
Credit	0.295***	0.105	0.000
Farm income	0.154**	0.486	0.043
Farming experience	0.100^{NS}	0.044	0.342
Tenure	0.015^{NS}	0.097	0.261
Slope	0.395**	0.094	0.048
Extension	0.162^{NS}	0.802	0.181
Training	2.001**	0.757	0.020

Hosmer and Lemeshow Test: Chi-square, 6.227; d.f. 11; Sig., 0.506. -2log likelihood, 83.67 (a); Cox & Snell R^2, 0.724; Nagelkerke R^2, 0.724. Overall percentage of right predictions, 92.5%.

*Note: *** and ** indicates 1 per cent and 5 per cent level of significant and NS indicate non-significant*

4. Conclusions and Implications

This study was carried out in order to better understand how efforts to promote soil conservation technologies should be targeted. This research yields a number of valuable results that shed light on how to promote the adoption of conservation measures. Age, education, sex, off-farm income, livestock, credit access, and training all have an influence on the adoption of the introduced soil conservation in the research area. Other characteristics like farm size, tenure, and extension services are not significant, although they are positively associated with the likelihood of soil conservation techniques being adopted. This means that regional and local governments should give farmers and extension service personnel with extension and training services on the newly introduced soil conservation measures. These measures encourage farmers to take soil conservation measures on their farm lands. Moreover, agricultural department of the state should take into account of these determining factors to augment the adoption of conservation practices which in turn will enhance the socio-economic status of the farmers.

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